Bonneville Power Administration South Bank Substation
Interstate Highway 84, south of Bonneville Powerhouse
Bonneville
Multnomah County
Oregon

HAER No. OR-4

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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service, Western Region
Department of the Interior
San Francisco, California 94102

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HISTORIC AMERICAN ENGINEERING RECORD

BONNEVILLE POWER ADMINISTRATION SOUTH BANK SUBSTATION
HAER NO. OR-4

Location: North of Interstate 84 south of Bonneville Dam Powerhouse and Navigation Lock, Bonneville vicinity, Multnomah County, Oregon

U.S.G.S. 7.5 minute Bonneville Dam, Washington and Oregon, quadrangle
Universal Transverse Mercator coordinates: 10.582200.5054155

Date of Construction: 1939

Designers: Dean R. Wright, BPA Chief Architect, and BPA electrical engineers

Builder: Drake, Wyman and Voss, Inc., Portland, Oregon

Present Owner: Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208

Present Use: Electrical substation
To be de-energized and demolished 1987

Significance: South Bank Substation was one of the first substations constructed by the Bonneville Power Administration. It is historically significant because it served to energize the BPA's first transmission line, which in turn provided electricity to the agency's first customer, the City of Cascade Locks, Oregon. The substation was determined eligible for inclusion in the National Register of Historic Places in 1986.

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Date: September 1987

DESCRIPTION

The Bonneville Power Administration's South Bank Substation (see photos 1 through 5) stands less than 50 meters south of the Bonneville Dam navigation lock on the south bank (Oregon side) of the Columbia River. Partially screened behind trees and a small hill, the modest, formed concrete control house is scarcely visible from the dam's powerhouse where the substation receives electricity via underground cables. Its diminutive size in comparison with the nearby dam reflects South Bank's relatively low voltage of operation (13.8 kilovolts), which in turn allowed for a design accommodating all original components within the building's interior. (Most higher voltage BPA substations have larger electrical equipment installed in outdoor "switching yards.") South Bank Substation was in 1939 and still is today the only BPA substation to be energized at 13.8 kilovolts and to be designed to house all electrical equipment internally.

Measuring 41 feet 8 inches by 27 feet 8 inches, the control house is a formed concreted mass with smooth-finished walls 8 to 10 inches thick and 13 feet 9 inches high (see photos 6 through 10 of elevation, floor plan, and miscellaneous detail drawings). The wall surface is stepped above and below the windows, giving the appearance of fascia-like bands for horizontal emphasis. The stepping also serves to distract from the inevitable imperfections visible in a formed concrete wall. The building retains its original fenestration of five steel sash windows on both east and west walls. Double flush panel, hollow metal doors set in metal frames are centered on the building's south end, and a single door of like material enters on the north end. Two metal louvers are mounted at ground level on both east and west walls.

Perhaps the structure's most distinctive feature is its low hipped, standing seam copper roof. Used primarily for their durability, copper roofs were installed on very few BPA substation control houses. Today their cost is prohibitive and they are not installed on any BPA buildings. On the South Bank control house, copper sheets were laid over a 4-inch-thick concrete slab covered with insulation and asphalt resting atop concrete roof beams. The edges of the adjoining sheets were folded together locking the sheets along raised or "standing" seams. The roof is surrounded by leadlined gutters which were formed on the spot by shaping the malleable metal into the concrete contours.

The single door at the north end of the building opens into a stairwell between the upper main floor and the basement. The main floor consists of a single open room in which is housed the metal-clad switching gear and other electrical equipment. Over the years, some equipment has been removed from the building, but much of the original apparatus installed in 1939-1940 is still in operation in the facility. Centered in the single room on the main floor are the original metal-clad control panels and cabinets (see photo 11). Mounted on the upper halves of the east and west sides of the panels are control and monitoring equipment. On the west side are the apparatus (see photo 12) that control the Power Circuit Breakers mounted in the cabinets below. All of the equipment on these panels is original. The various apparatus are clustered on two adjacent panels, with each cluster serving one of the substation's two customers, the U.S. Army Corps of Engineers and the City of Cascade Locks, Oregon. Identical devices are mounted within each cluster, reflecting their identical function.

Arranged vertically in the center of each cluster are four black boxes with glass faces. The uppermost box contains a Megawatt Meter, while the lower three house Ampere Meters, all measuring and monitoring the amount of power going to the facility's two customers. To the left of the meters is a Voltage Chart Recorder, and to the right is a Reclose Relay, functioning to reclose (or reconnect) the circuit if broken by the Power Circuit Breaker below. Centered under the clusters behind glass are Testing Switches, to which are attached equipment used for testing the control and monitoring apparatus. The testing equipment is portable and is not shown attached to the switches in the photo (12).

Below the Testing Switches are two handles which serve as Breaker Switches. Their functions are to close (that is, connect or turn on) and open (disconnect or turn off) a circuit. Red and green lights above the switches indicate whether the circuit is on (red light) or off (green light). There are two circuits or lines connected to each customer's feeder line, hence the two pairs of switches on each panel.

Mounted behind the hinged metal doors immediately below the Breaker Switches are two Power Circuit Breakers (PCBs) (see photo 13), one per cabinet. These original pieces of equipment, painted black and bearing a Westinghouse label, are suspended approximately 8 inches above the floor. Their function is to control the flow of current into the outgoing lines. One PCB is always "on line" (or closed, that is conducting current), while the other serves as a backup. A PCB breaks (opens or shuts off) the 13.8 kilovolt circuit should there be a fault (interruption of electrical current flow) along the transmission line supplying power to the customer. Current flow can be turned on or shut off manually by throwing the Breaker Switch on the panel above. The PCBs can also be closed automatically by activation of the Reclose Relay on the panel above.

On the opposite (east) side of the bank of metal-clad panels and cabinets on the main floor are mounted still more control and monitoring equipment (see photo 14). Unlike the apparatus mounted on the west side, some of the equipment on the east side is modern, having replaced the function of the older devices. Like the west side, the control and monitoring equipment is mounted on two adjacent panels above two Power Circuit Breakers situated in metal cabinets immediately below. (As on the other side of the cabinets, the PCBs are original). Above on the panels, the older original equipment is situated on the left and the modern apparatus on the right. Of the original devices, the upper four glass boxes are Overcurrent Protective Relays, which, when operational, functioned to detect ground and phase (line) faults and to open the Power Circuit Breakers below, that is, to shut off electrical current flow. That function is now performed by the Protective Service Relays, the four black boxes near the top of the right hand panel.

Immediately below the Overcurrent Protective Relays and Protective Service Relays are eight rectangular glass units (four per panel) containing Testing Switches, which function exactly as do those on the west side panels. Switches on the left hand panel are original, while those on the right are modern. Below the Testing Switches on the left panel are two large, glass-covered black boxes called DG1 Metering Chart Recorders which, when functional, recorded the wattage (amount of power) used by the customers. Their function has been taken over by the modern Remote Metering System housed in the light-colored metal box immediately to the right.

No original equipment remains in the basement, which consists of a single room with concrete floor and walls. Running the lengths of both the east and west walls are three-foot-high concrete shelves designed to support six electrical reactors on each side (see photo 15). Only six reactors were ever installed, all on the north ends of the shelves, three reactors per side. The function of the reactors was to limit the volume of current entering the substation, thereby protecting the facility's equipment from surges of electrical current resulting from electrical faults (short circuits). The six reactors were mounted on concrete pads (see photo 16) measuring 3 feet by 3 feet 6 inches and 8 inches high. The pads are now enclosed within frame and wire screens. Signs warn visitors of the high voltage buses (underground transmission cables) entering the substation via porcelain-lined cable ducts at the north end of the basement just above the floor (visible in photo 15 near the far end of the wire-enclosed reactor area). Isolating transformers housed in metal cabinets surrounded by a chain link and barbed wire fence adjacent to the east side of the substation (clearly visible in photos 1 through 4) assumed the function of the removed reactors.

On the east (exterior) wall of the building, brackets are attached to a panel over the upper levels of two windows. The brackets once supported so-called potheads, which served as insulators for overhead conductor cables on a 13.8 kilovolt transmission line. The potheads were not original equipment in the substation, but rather were installed subsequent to construction and removed when the line was taken out of service. Attached to the wall below the panel and brackets are metal conduits which enclosed the wiring running from the potheads to the reactors in the basement, which have also been removed. The panel, brackets, and conduits represent the only changes in the structure's exterior appearance since it was built in the summer of 1939.

SIGNIFICANCE

The Bonneville Power Administration built South Bank Substation in 1939 to service the newly-created agency's first transmission line. When completed in August of that year, the modest formed concrete structure shared honors with the control house at the Eugene, Oregon, substation as the first permanent substation buildings erected in the rapidly expanding BPA transmission grid system. Unlike the Eugene Substation, however, South Bank was built to serve only a local area at a 13.8 kilovolt level and not at the 230 and 115 kilovolt level at which the main transmission grid was being built by BPA in 1939-1940. As a result of its design for relatively low voltage operational level, South Bank never figured prominently in the regional grid system.

Nevertheless, the South Bank control house was then, and is today, unique in the system in that it was built to house on its interior all the electrical equipment normally found outside a control house in a switching yard. The building appears almost exactly as it did the day it was completed, overwhelmed by the immensity of nearby Bonneville Dam where generation of unprecedented amounts of electricity in the late 1930s gave rise to the need for a regional public power authority. That Federal agency, the Bonneville Power Administration, took its name from Bonneville Dam and, until January 1940, was known simply as the Bonneville Project. Originally within the U.S. Department of the Interior, the BPA is now a part of the U.S. Department of Energy. Although not yet 50 years old, South Bank Substation is a reminder of the earliest construction projects of the BPA, whose scores of substations and thousands of miles of transmission lines now extend across a five-state region.

As Bonneville and Grand Coulee dams neared completion in the mid 1930s, Congress created the Bonneville Power Administration as a regional Federal power agency somewhat like the Tennessee Valley Authority in the Southeastern U.S., which had been established in 1933. While the U.S. Army Corps of Engineers had built Bonneville Dam and the U.S. Bureau of Reclamation was at work on Grand Coulee, the BPA was charged with marketing and transmitting the tremendous electrical power generated at the new facilities. Planning an interconnected network of substations and transmission lines between dams and population centers consumed most of the new agency's first two years of operation.

Within its first year, the BPA had constructed its first transmission line serving its first customer. On July 9, 1938, Secretary of the Interior Harold Ickes threw the switch for the first transmission of electricity generated at Bonneville Dam to the City of Cascade Locks 3.4 miles to the east. A single circuit 6.9 kilovolt wood pole line carried the power the relatively short distance in what was a largely ceremonial display anticipating greater things to come. The small city was but the first of many BPA customers, and the modest transmission line merely a demonstration of the new agency's capabilities to deliver the rapidly increasing quantities of hydroelectric power throughout the region.

The following year, the BPA began constructing larger, steel-tower transmission lines of 115 and 230 kilovolts over great distances in Oregon and Washington. Construction also began on substations to service those lines, as well as smaller facilities such as the Bonneville to Cascade Locks line. In its haste to energize the first transmission line to the first customer, the BPA had installed a temporary high tension bus (conductor) connecting the Bonneville Dam powerhouse directly to the line to Cascade Locks. That temporary arrangement lasted over one year until South Bank Substation was put in operation to ensure uninterrupted service to its localized customers.

Prior to erecting any of the facilities, the System Engineering Section of the BPA drew up general plans for fourteen substations to be included within the original grid plan. System Engineering then turned to the Substation Engineering Section, which prepared the specifications for heavy equipment and fittings needed for each installation. Finally, after the grand scheme had been determined, the Architectural and Drafting Section was given the task of preparing individual building designs. Referring to the overall process of substation design, a 1939 BPA Engineering Division report stated:

> The task was made difficult at the start by the lack of any previous construction on the [Bonneville] Project to use as a guide. It was necessary to build up a reference file consisting of catalogues, drawings, specifications, and technical information from various other substations and construction jobs in all parts of the country.

Chief of the Architectural and Drafting Section in the late 1930s was a man who would leave his mark on the agency's history if for no other reason than the fact that he affixed his signature to every drawing produced there for many years. Dean R. Wright served as Chief Architect at BPA from the late 1930s into the 1950s, and in other capacities with the agency until his death in the early 1970s. His signature appears on elevation drawings of South Bank Substation, as well as on design drawings of other substation buildings, transmission towers, electrical circuitry, and maps of facilities. Wright obviously could not have personally designed every detail of every facility. Most likely he designed in a very general manner South Bank Substation as he did most of the early BPA buildings. George Poole, presently an architect with BPA, worked for a number of years under Dean Wright and described the standard procedures in Wright's design process:

> Wright was a "Victorian School" architect. His designs were more art than science. He paid scant attention to technical aspects of design. He never worked at a drafting table, never took off his coat and rolled up his sleeves. He sketched designs on a small breadboard on his lap, then passed the sketch on to his architects who would work out the design details around his general idea of what the structure should look like.

Problems often developed when engineering specifications could not be accommodated in the Chief Architect's initial sketch design. Such problems arose, George Poole believes, because Wright was "basically ignorant of architecture and didn't understand the discipline." Wright apparently was not a licensed architect, but had, prior to joining BPA, helped design a number of buildings, including Timberline Lodge on the slopes of Mount Hood. His role in designing the lodge was minor, however, like that of many local architects and draftsmen who worked on the Federally-sponsored, Depression-era project.

Dean Wright's involvement in the design of South Bank Substation is not known for sure, but it is presumed that he sketched the building's exterior appearance before draftsmen prepared detailed elevations. Neither that sketch nor any other of Wright's "rough drafts" are known to have survived in the agency's archives, but it was probably very basic and simple, based on the few precedents available at the time. Some standardization in design was already then present, as indicated in the agency's Annual Report for the year 1939:

> The substation buildings are designed on a unit basis so that each unit will present a complete and appropriate structure that may have additional units added as the needs of the substation increase.... From an architectural viewpoint the most interesting feature of a substation is the control house, where plain wall surfaces are interrupted only by carefully proportioned window and door openings.
>
> Particular attention is being given to the selection of materials on basis of durability and low expense of upkeep.... Landscaping has been made an integral part of the design of the substations to achieve natural, dignified, and pleasing structures.

The South Bank control house was probably an exception to the standardized "unit basis" design. Other substations operating at higher voltages had control houses designed to contain switching gear (control panels), monitoring instruments, and other devices not occupying a great deal of space, while large, heavy electrical equipment (such as transformers, capacitor banks, etc.) was installed in outdoor switching yards. When additional 115 and 230 kilovolt lines were later routed through the substations and the switching yards expanded, the control houses could then be enlarged to accommodate the necessary control and monitoring panels. South Bank, on the other hand, was not designed for expandability, but rather to serve a limited number of local customers at low voltage. Increasing the substation's operating level to 115 or 230 kilovolts would have required larger electrical equipment that could not have been housed economically in the interior of a control house. Space was provided in the basement for six additional electrical reactors which were never installed, but the additional reactors would not have increased the voltage level of the substation. There does not seem to have ever been any thought given to increasing South Bank's operational level beyond 13.8 kilovolts, nor to expanding the size of the control house. And unlike at other substations within the 115 and 230 kilovolt grid system, the grounds around South Bank were apparently never landscaped, although early elevation drawings show the control house standing amidst trees, shrubs, and a manicured lawn. Perhaps the substation's nearness to the dam precluded landscaping ground often impacted by heavy vehicular traffic or other activities relating to operation of the powerhouse or navigation lock.

After initial design work had been completed on South Bank and the thirteen other substations planned for the original grid, BPA officials decided, apparently for financial reasons, to temporarily postpone building most of the facilities. Actual construction then proceeded on only four substations: North Vancouver (now called Ross), St. Johns (in northwestern Portland), Eugene, and South Bank. The firm of Drake, Wyman and Voss, Inc., of Portland was awarded a contract for $11,348 to construct the concrete control house at South Bank. Excavation for the building's foundation began in mid May 1939 at the site, situated immediately south of the navigation lock and powerhouse at Bonneville Dam (see photos 17 through 20). The site was no doubt chosen for its near proximity to the powerhouse, from which underground cables would eventually be laid to the substation.

Removal of unpredictably large amounts of rock delayed construction on South Bank for a time, but by August 15th the building was ninety-nine percent complete. By then the control house at the Eugene substation was reportedly also ninety-nine percent complete, and the temporary buildings at North Vancouver (Ross) were "well under way." (Temporary frame structures were also initially installed at St. Johns, the other substation then under construction.) Engineers optimistically predicted that South Bank would be fully operational by October 1st, but it was not until early March 1940 that all tests of the electrical equipment had been completed and the substation energized.

As a result of the unexplained delay, South Bank became the second BPA substation to be energized and fully operational. Only a few days earlier, on February 24, 1940, the Eugene substation became the first facility to have the "full voltage applied to the station bus," as the Engineering Division proudly reported. South Bank was energized via a temporary overhead line from the dam powerhouse, pending completion of the underground cable ducts. Work began on March 20th on duct excavation, much of which was done by hand through solid granite. (Apparently explosives were not used for fear of damaging the nearby powerhouse.) Two lead-covered cables containing three conductors each attached to potheads (insulators) on the building's south wall were routed through ducts under the Union Pacific Railroad tracks to a cable pole some distance to the south. There they connected to an overhead conductor feeding the Cascade Locks line, which was increased from 6.9 to 13.8 kilovolts. The BPA's first transmission line was then finally energized by way of a reliable source, that being South Bank Substation.

Substations were then and are today built to serve a variety of purposes depending upon their locations. As control and transfer points within an electrical transmission system, they may serve to:

1. route and control electrical power flow;
2. transform a voltage to a higher or lower voltage;
3. function as a delivery point to an individual customer; in BPA's case, a private or publicly-owned utility or a heavy industry such as an aluminum plant.

Individual substations can be designed to accommodate equipment for one or any combination of the above purposes. South Bank Substation was built to route and control the power flow for the small wood pole transmission line serving the City of Cascade Locks. Other customers subsequently were served by the substation within its limited fifteen-mile distribution zone, including the Skamania County, Washington, Public Utility District to the north across the river and the Corps of Engineers Hydraulic Laboratory at Bonneville Dam.

The design of the South Bank control house reflected the nature of the components it housed. Since the substation was to be unattended (i.e., unmanned), there was no need for a control room where an operator would sit at a desk, like at the Eugene substation and most of the other facilities then being built. Instead, reclosing circuit breakers were installed at South Bank which would reclose automatically if opened by a short circuit. The reactors housed in the basement functioned to limit electrical currents resulting from short circuits. They were installed in favor of larger, more costly oil-based circuit breakers common in outdoor switching yards at other substations. In addition, the relatively low voltage at which the station was designed to operate did not require the larger oil-based circuit breakers.

The South Bank control house was designed to accommodate installation of four supply cables from the Bonneville Dam powerhouse, twelve single-phase 13.8 kilovolt reactors, two 1200-ampers/15 kilovolt reclosing circuit breakers, and 13.8 kilovolt double-bus metal clad switch gear. By the end of June 1940, four circuit breakers, six reactors, and various other equipment had been installed. For reasons unknown, only the six reactors were ever installed on the specially-designed platforms in the basement. With all components fully automated and protected from the elements within a sturdy, concrete building, engineers predicted that "service can be maintained under the most adverse conditions."

In the nearly fifty years since its construction, South Bank Substation has maintained continuous service to the City of Cascade Locks. Until ca. 1982 it also provided electrical power to the nearby Corps of Engineers Hydraulic Laboratory. Although the reactors have been removed from the basement and replaced by isolating transformers on the building's exterior, and a few minor modifications made of other equipment, the substation has remained remarkably unchanged. Its virtually unaltered appearance and nearly complete assemblage of original equipment, as well as its diminutive size, serve as vivid reminders of the infancy of the Bonneville Power Administration.